

Based on National Curriculum of Pakistan 2022-23

Textbook of General Science Grade 9

National Curriculum Council
Ministry of Federal Education and Professional Training



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as
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A Textbook of General Science for Grade 9
based on National Curriculum of Pakistan (NCP) 2022-23

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Note

All illustrations, artwork, and images in this book are intended solely for educational and promotional purposes, benefiting the public interest.

Preface

This General Science Grade 9 has been developed by NBF according to the National Curriculum of Pakistan 2022-2023. The aim of this textbook is to enhance learning abilities through inculcation of logical thinking in learners, and to develop higher order thinking processes by systematically building the foundation of learning from the previous grades. A key emphasis of the present textbook is creating real life linkage of the concepts and methods introduced. This approach was devised with the intent of enabling students to solve daily life problems as they grow up in the learning curve and also to fully grasp the conceptual basis that will be built in subsequent grades.

After amalgamation of the efforts of experts and experienced authors, this book was reviewed and finalized after extensive reviews by professional educationists. Efforts were made to make the contents student friendly and to develop the concepts in interesting ways.

The National Book Foundation is always striving for improvement in the quality of its textbooks. The present textbook features an improved design, better illustration and interesting activities relating to real life to make it attractive for young learners. However, there is always room for improvement, the suggestions and feedback of students, teachers and the community are most welcome for further enriching the subsequent editions of this textbook.

May Allah guide and help us (Ameen).

Murad Ali Mohmand
Managing Director

UTILITY OR PRACTICAL APPLICATIONS OF THE SUBJECT

- 1. Nature of Science:** It explains the philosophical assumption in the practice of sciences. It also explains the nature of science and relationships between different branches of science. Its application is in scientific collaboration.
- 2. Cells and Tissues:** It establishes an understanding of a cell as basic unit of life. Its application is describing the structure and functions of cells and tissues in plants. The study of cells is important in order to learn about processes such as reproduction, growth etc. The study of cells is vital to know about other fields associated with biology such as biotechnology, medicine, genetics, forensic science, and various others.
- 3. Biodiversity:** The application of biodiversity is that humans depend upon biodiversity for survival, such as for, medicines we use to stay healthy, and materials we wear or use to build our homes. Without a wide range of animals, plants and microorganisms, we cannot have the healthy ecosystems that we rely on to provide us with the air we breathe and the food we eat.
- 4. Atomic structure:** Atomic structure and isotopes have practical uses, such as in medical imaging with radioactive iodine for diagnosing medical issues. Atomic energy levels explain light and color, used in LEDs and screens. Electron behavior informs battery and electronics design.
- 5. Chemical bonding:** Understanding chemical bonding has numerous applications in daily life and industry. Ionic compounds, known for high melting points and conductivity in solutions, are used in batteries and electrolytes. Covalent bonding principles guide the creation of polymers, plastics, and pharmaceuticals, essential in packaging, medicine, and textiles. Knowledge of bond types allows chemists to design alloys and materials with desired properties.
- 6. Energy resources:** Carbon plays a crucial role in the structure of all living organisms. Human activities, such as burning fossil fuels, release carbon dioxide, contributing to the greenhouse effect, which warms the planet. Smog formation from industrial emissions impacts air quality and visibility, while greening skills promote sustainable practices in professional settings. Solar ovens exemplify practical applications of renewable energy, using sunlight for cooking.
- 7. States of Matter:** Matter has mainly three states i.e. solid, liquid and gas. Solid matter has numerous applications in our daily life for example solid materials like bricks, wood and metals can be used in construction, kitchen appliances, utensils and even the household furniture all are solid, components of electronic devices like computers and smart phones are made up of silicon a solid material. On the other hand liquids also have many applications in our daily life like we use liquids for drinking like water, milk and other beverages water is essential for all living organisms, similarly we use some liquid medicines which are easy for consumption. In case of gases as we know that no life can exist without oxygen which is a gas hence it is essential for all life on the Earth, natural gas and some other organic gases are used as fuel and cooking.
- 8. Measurement:** Measurement is fundamental to our everyday activities like in cooking the ingredients are often measured in grams, liters, milliliters to ensure recipe turn out correctly, the motions and distances travelled some of the physical quantities which are measured in our daily life routine, lengths are usually measured in setting our household item in our room, in making

our homes etc. power consumption is also measured for calculations of electricity bills. Fruits, vegetables and other commodities are often sold by using measurement for those quantities. Currency is counted and measured in various denominations. For every task in our daily routine we measure the time intervals for each task and finally the precise measurements of physical quantities like time, temperature, volume and mass are essential for scientific experiments.

9. Force and Energy: Force and energy are the essential parts of our everyday life like the force of gravity keeps us grounded, without it we would not be able to walk or stay on the ground, gravity keeps planets in orbit around the sun and moons around the planets it also causes water to flow from higher to lower points which is crucial for plumbing systems. Infact we walk due to the force of friction between our shoes and the ground similarly the frictional force between the tires and the road enables a car to move. We can write our homework due to force of friction between the page and the pen, friction is also important for stopping a car by applying brakes which work due to the force of friction. We need daily life appliances which are energy efficient like air conditioner, washing machines and refrigerators etc. to save energy. Fuel efficient vehicles help save money and also reduce environmental impacts. In nature we have a lot of energy resources which meet our everyday needs. Some of them are renewable while other are non-renewable energy resources, like oil, natural gas and coal are some primary energy resources while solar panels, wind turbines and hydropower generators generate energy in a sustainable manner. Organic materials like wood and agricultural waste are used to produce bioenergy.

10. Heat: Heat and temperature are essential for life as life can exist only within a narrow range of temperatures in which the water can be found in liquid state this temperature range exists around every star at a particular distance which is known as "Goldilocks zone". Our Earth revolves around the sun in the sun's goldilocks zone. This temperature range is crucial in the search for potentially habitable planets. Heat is also used for cooking food, making our homes warm during winter and in many industrial processes like metal forging and glassblowing. Pots and pans conduct heat from the stove to the food through conduction, materials with low conductivity are used in buildings to reduce heat loss and improve energy efficiency. Natural convection drives ocean currents and atmospheric circulation making effects on climate and weather patterns. The sunlight and energy reaches to Earth through radiation which sustains the life of the planet. Microwave ovens use radiation to heat food quickly and efficiently. The thermal radiations are also used to make images of living things in dark, due to the invisible radiations which living bodies emit.

Managing Author

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ
اللہ کے نام سے شروع جو بڑا مہربان، نہایت رحم والا ہے

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NATURE OF SCIENCE

SLOs: After completing this lesson, the student will be able to:

1. Explain the nature of science.
2. Enlist the main branches of science and explain their applications.
3. Describe the relationship between different branches of science and name some interdisciplinary fields of science.
4. Justify with examples that science is a collaborative field that requires interdisciplinary researchers working together to share knowledge and critique ideas.

1.1 NATURE OF SCIENCE

Science comes from the Latin word *scientia* meant knowledge or learning. When you look at the sky at night you observe moon and stars. You wonder why moon and stars are not seen at the day time. Asking this type of question is the first step in doing science. Science is the process of collecting information about the world around us. Much of the time, the first step in collecting information is asking question. The study of science helps us answer how, what, where and why of our surroundings.

The conclusion of science is subject to change. In science, new studies utilize new techniques and equipment. These might modify or change the previous conclusion. The ultimate goal of science is to understand the natural world in terms of concepts based on conclusions of experiments and observations. Science is a human work. It is a growing and exciting search for what is true. In this sense science is a way of solving problems. For example how can we protect plants from diseases?

1.1.1 MAIN BRANCHES OF SCIENCE AND THEIR APPLICATIONS

Science is a very vast subject. It has been divided it into some specific branches, so that its study can become simple and easier.

Branches of Science

Modern Science is mainly consists of three main branches. The three main branches of Science are: natural science, social science and formal science.

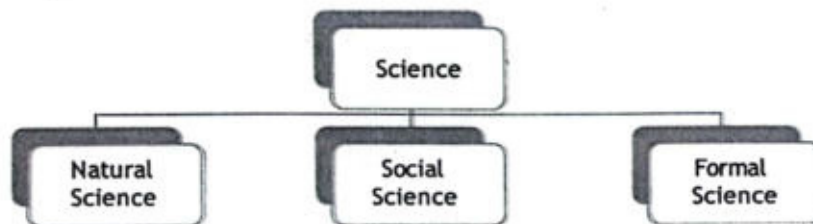


Fig.1.1: Branches of science

1. Natural Sciences

It is the study of the nature of our physical world and the universe.

Branches of Natural Science

Modern scientific study is divided into three major branches, namely physical sciences, life sciences, and earth sciences. However, Earth Sciences are often included within physical sciences.

1. Physical science

It is the study of the universe.

2. Life science

It is the study of life and living organisms.

3. Earth science

It include all fields of natural science related to the planet Earth.

Table 1.1. List of Branches of Natural Sciences and Their Sub-Fields

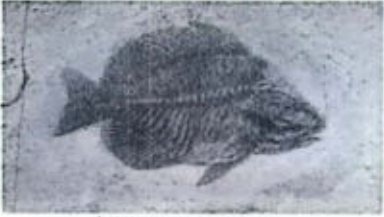
Physical Science	Life Science	Earth Science
Physics: It involves the study of everything in physical existence, from the smallest subatomic particles to the entire universe. Mechanics: It is the relationships between force, matter and motion among physical object. Electromagnetics: It deals with the electromagnetic force that occurs between electrically charged particles. Thermodynamics: It deals with the energy and work of a system. Kinetics: It deals with the effects of forces upon the motions of material bodies. Chemistry: Properties of substance and the changes they undergo. Organic chemistry: It is the study of carbon and its compounds. Inorganic chemistry: It is the study of compounds that don't contain a C-H bond. Physical chemistry: It applies physics to the study of chemistry Analytical chemistry: It is the study of the chemistry of matter. Biochemistry: It is the study of chemical processes that occur inside of living organisms.	Botany: The branch of biology that deals with the study of plants. Zoology: It is the branch of biology that deals with the study of animals and animal kingdoms. Microbiology: It is the study of microscopic organisms. Marine biology: It is the study of marine organisms. Genetics: It is the study of how genes and how traits are passed down from one generation to the next. Ecology: It is the study of organisms and how they interact with the environment around them. Paleontology: It is the study of the history of life on Earth as based on fossils. Fossils are the remains of plants, animals, fungi, bacteria, and single-celled living things that have been replaced by rock material or impressions of organisms preserved in rock.  Cell biology: It (also called cellular biology or cytology) is a branch of biology that studies the structure, function, and behaviour of cells.	Astronomy: It is the study of everything in the universe beyond Earth's atmosphere. It includes objects that we can see with our naked eyes, like the Sun, the Moon, the planets, and the stars, and objects we can only see with telescopes or other instruments, like faraway galaxies and tiny particles. Meteorology: It is the science of weather. Geology: It means study of the Earth, also known as geoscience or Earth science. Geology is the primary Earth science and looks at how the Earth formed, its structure and composition, and the types of processes acting on it. Atmospheric science: It is the study of weather analysis and predictability, climate and global change, the circulation of the atmosphere relating to weather systems and their impact on the Earth, air quality, and other atmospheric processes that affect us. Glaciology: It is the study of snow and ice. It also includes the study of movement and physical properties of glaciers. Climatology: It is the study of the atmosphere and weather patterns over time. It focuses on recording and analyzing weather patterns throughout the world.

Fig. 1.2: Fossil

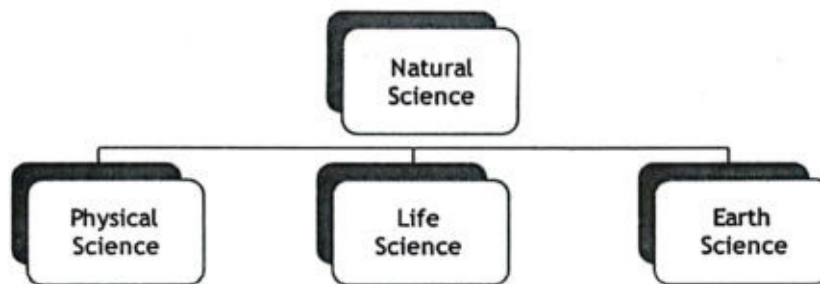


Fig.1.3: Branches of natural science

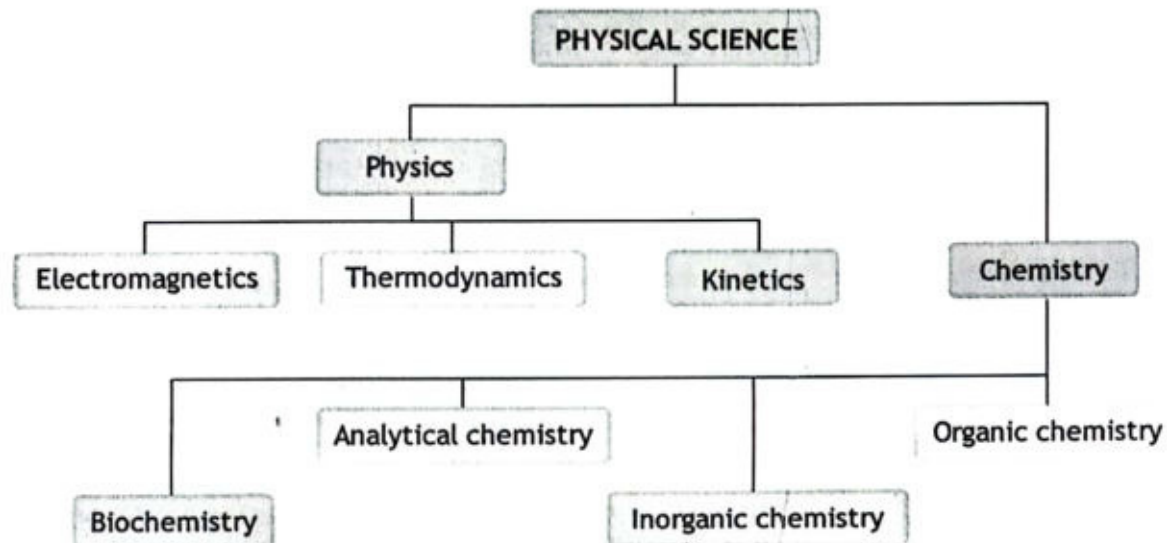


Fig.1.4: Branches of physical science

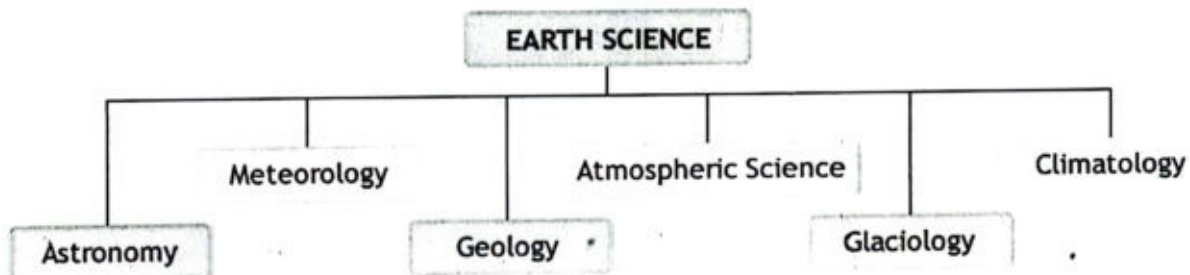
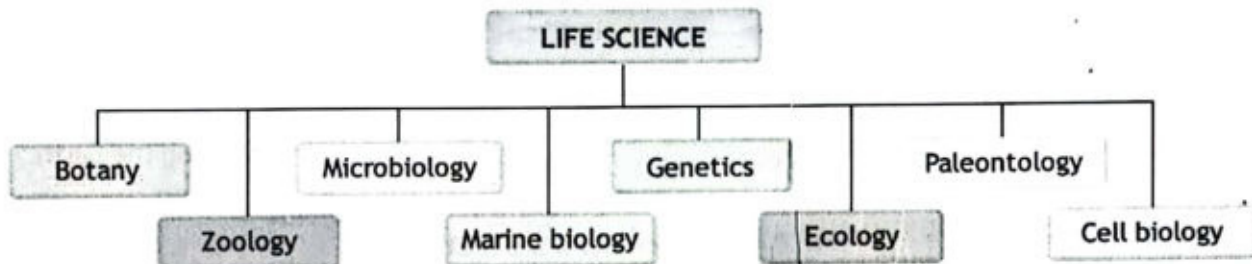


Fig.1.5: Branches of earth science

Applications of Natural Science

It is applied in Engineering, Agricultural science, Medicine and Pharmacy. The natural sciences have been changing our living and thinking ways.

It promotes critical thinking: Critical thinking includes asking questions, examining evidence and information and later coming to a conclusion. All these factors are usually essential in all-natural science.

Helps in developing analytical and organizational skills: Natural science develops excellent analytical skills. This is attributed to the use of existing theories to solve problems and also come up with inventions. Analytical skills help to draw valid conclusions from lab experiments conducted. Natural science students develop organizational skill. This skill is not only essential in school but also benefit the students while in the professional world.

It is a great way to start a good career: Studying natural science acts as a good way to start a career in scientific research, scientific analysis and also in testing and investigation.

Helps to understand the natural world: Studying natural science is vital as it helps to acquire analytical skills, critical thinking skills and gives an understanding of the natural world.

Some common careers involving physical science are:

1. **Physicist:** Physicists are responsible for creating and testing theories in physics.
2. **Quantum physicists:** Quantum physicists are scientists who specialize in quantum physics, which involves the behaviour of the universe at an atomic and subatomic scale.
3. **Chemists:** Chemists are scientists who conduct experiments on molecular matter. They often test and create different chemicals for a variety of purposes.
4. **Astronomers:** Astronomers are scientists who study the universe outside of Earth, including galaxies, planets and stars.
5. **Computer scientist:** Computer scientists can also benefit from a physics background. Computer scientists are responsible for finding ways to use computers to solve problems.

Some common careers involving life sciences are:

1. **Marine biologist:** Marine biologists are scientists who study marine life.
2. **Pharmacologists:** Pharmacologists are scientists who study and develop medications to treat diseases.
3. **Forensic scientist:** Forensic scientists are responsible for analyzing crime scenes and evidence to help solve crimes. Often, forensic scientists examine evidence in laboratories.
4. **Agricultural scientist:** Agricultural scientists study and conduct experiments related to crops and farm animals to help improve the industry of farming.
5. **Virologist:** Virologists are scientists who study viruses to develop methods to prevent virus infections and outbreaks.

Some common careers involving Earth sciences are:

1. **Meteorologist:** Meteorologists are responsible for analyzing the weather and preparing weather forecasts.
2. **Land planners:** Land planners can also use knowledge of earth science. Land planners are responsible for planning how to regulate and develop the land.
3. **Geologists:** Geologists are scientists who study rocks and other solid parts of the earth and other planets.
4. **Paleontologists:** Paleontologists are scientists who study the earth's history by examining fossils.
5. **Environmental scientist:** Environmental scientists are concerned with the earth's environment. They can use knowledge of earth science to come up with ways to protect the health of the earth and the health of humans

2. Social Science

Social Sciences study human societies from across the globe as well as the relationship of human beings with their social environment.

The main branches of social sciences are:

1. **Psychology:** It is the scientific study of the mind and behaviour.
2. **Sociology:** It is the study of social life, social change, and the social causes and its result on human behaviour.
3. **Anthropology:** It is the study of the origin and development of human societies and cultures.
4. **Economics:** It is the study of scarcity, the study of how people use resources and respond to incentives.
5. **Archaeology:** It is the study of the ancient and recent human past through material remains.
6. **History:** The study of past events, particularly in human affairs.
7. **Geography:** It is the study of Earth's landscapes, peoples, places, and environments.
8. **Law:** It is a rule of conduct developed by the government or society over a certain territory. Law follows certain practices and customs in order to deal with crime, business, social relationships, property, finance, etc.
9. **Politics:** It is the activity of government and those involved in the process of governing. It is closely related to the field of political science.

Applications of Social Sciences

1. Social scientists help us imagine alternative futures.
2. Social science can help us make sense of our finances.
3. Social scientists contribute to our health and well-being.
4. Social science might save your life.
5. Social science can make your neighbourhood safer.
6. We need social scientists as public intellectuals.

7. Social science can improve our children's lives and education.
8. Social science can change the world for the better.
9. Social science can broaden your horizons.
10. We need social science to guarantee our democracy.

3. Formal Science

It is quite a unique area of study in science. It uses formal systems to produce knowledge. It explores the nature of different disciplines ranging from mathematics, and logic to computer science and Information technology etc.

The most important branches of formal sciences are:

1. **Mathematics:** It is the science and study of quality, structure, space, and change.
2. **Logic:** It is the science of the formal principles of reasoning.
3. **Computer Science:** It focuses on the development and testing of software and software systems.
4. **Data Science:** It is the study of data to extract meaningful insights for business. It combines principles and practices from the fields of mathematics, statistics, artificial intelligence, and computer engineering to analyze large amounts of data.
5. **Statistics:** It is a mathematical body of science that pertains to the collection, analysis, interpretation or explanation, and presentation of data.
6. **System Science:** It is an interdisciplinary field that studies the complexity of systems in nature, social or any other scientific field.
7. **Artificial Intelligence:** It is a rapidly evolving technology. It tries to simulate human intelligence using machines, enabling them to perform a wide range of tasks, from simple to complex.
8. **Information Technology:** It is a set of related fields that encompass computer systems, software, programming languages and data and information processing and storage. It forms part of information and communications technology.

Applications of Formal Sciences

A "formal science" is an area of study that uses formal systems to generate knowledge. Formal sciences are important subjects because all of quantitative science depends on them. It is applied in computer science, statistics, mathematics. The formal sciences aid the natural and social sciences by providing information about the structures used to describe the physical world.

For Your Information

Applied Sciences

In applied science it is study about how to theories of a subject apply for the humans' applications. Such as making inexpensive fuels for energy requirements. This branch is a significant branch of science. Because we want an application from science rather than knowing the theories. All of the industrial applications come with applied sciences studies. Also, all of the science subjects have an applied science area, for example, applied physics, applied mathematics, applied biology, etc.

1.3 RELATIONSHIP BETWEEN DIFFERENT BRANCHES OF SCIENCE

While branches of science may seem distinct, they are often interconnected. For example, natural science and social science may overlap in fields such as environmental science, where scientists study the impact of human behaviour on the natural world. Similarly, formal science can be applied to the natural and social sciences to create mathematical models that help explain complex phenomena. Ultimately, all the branches of science are part of a broader effort to understand the world we live in and our place within it.

Examples of interdisciplinary fields of science

Biochemistry, Bioinformatics, Cognitive Science, Complex systems, Physics, Artificial intelligence, Biomedical engineering, Chemistry and Ecology etc., are the few examples of interdisciplinary fields of science.

Cognitive science: It is the interdisciplinary, scientific study of the mind and processes with input from linguistics, psychology, neuroscience, philosophy, computer science, and artificial intelligence.

Complex system: Examples of complex systems are Earth's global climate, organisms, and the human brain, infrastructure such as power grid, transportation or communication systems.

Bioinformatics: It is an interdisciplinary field of science that develops methods and software tools for understanding biological data.

Biomedical engineering: It is the application of the principles and problem-solving techniques of engineering to biology and medicine.

1.4 SCIENCE IS A COLLABORATIVE FIELD

When two or more scientists work together to achieve a common goal, it is called **scientific collaboration**. This can be in the form of sharing data, working together on a research project. In science, collaboration is about sharing information, resources, and ideas.

Meaning of Collaboration in Science: The meaning of collaboration is to work with other people to solve major problems. Scientists can collaborate with each other on different levels. For example, one scientist may need help from another scientist to run an experiment or get a piece of equipment for the experiment. Scientists may also collaborate with people outside their field of study, such as historians or other scientists, who are studying different things but have information that could be helpful for a particular project.

Importance of Collaboration in Science: Due to collaboration scientists can make new discoveries, improve their work and share their findings with the world. When a group of scientists collaborates on a project, they can pool their resources. Thus, they can do more work in less time. Collaboration also helps people learn from one another.

Public health combines information from medicine, sociology, and psychology. There was a special issue about research collaboration during the COVID era. It was showing how it is good for both science and society when we work together across borders, cultures, and different fields of study.

Example of Science Collaboration: One famous example of scientists working together is the International Space Station, where space agencies from Europe, the USA, Russia, and Japan all team up. In order to keep moving science forward, we need everyone involved—from students to teachers—to collaborate and share ideas, data, and results.

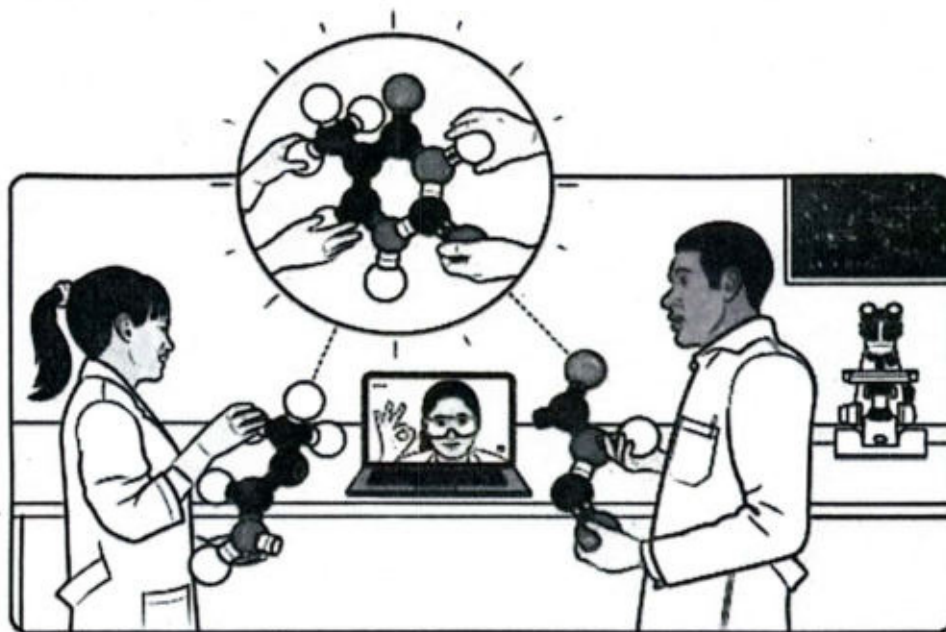


Fig. 1.6: Collaborative learning

Do You Know?

A STEAM activity is a lesson that covers the core STEAM subjects: Science, Technology, Engineering Arts and Math.

STEAM ACTIVITY 1.1

Topic: CLIMATE CHANGE

The teacher will divide the students into three groups. Each group may comprise of 3-5 students, and give each group different subtopics related to climate change. The students will investigate or research on the topics given.

Group 1: Causes of climate change.

Group 2. Effects of climate change.

Group 3. To overcome the problem of climate change.

- The students will be given five days to prepare their research work.
- Each group will read their research paper in the classroom before the students.
- Then the teacher will ask each group to work together and prepare a joint research paper on 'Climate change' and submit.

SUMMARY

1. Science means knowledge or learning.
2. Science is the process of collecting information about the world around us.
3. Science has been divided into some specific branches, so that its study can become simple and easier.
4. The three main branches of science are: Natural Sciences, Social Sciences, and Formal Sciences.
5. Natural Sciences is the study of the nature of our physical world and the universe.
6. The three major branches of natural science are: Physical Sciences, Life Sciences, and Earth sciences.
7. Physical science is the study of the universe.
8. Life science is the study of life and living organisms.
9. Earth science includes all fields of natural science related to the planet Earth.
10. The main branches of Physical Science are Physics and Chemistry.
11. The main branches of Physics are Mechanics, Electromagnetics, Thermodynamics and Kinetics.
12. The main branches of Chemistry are Organic Chemistry, Inorganic Chemistry, Analytical chemistry and Biochemistry
13. The main branches of Life science are Botany, Zoology, Microbiology, Marine Biology, Genetics, Ecology, Paleontology and Cell biology
14. The main branches of Earth Science are Astronomy, Meteorology, Geology, Atmospheric Science, Glaciology and Climatology
15. Natural Science is applied in Engineering, Agricultural science, Medicine and Pharmacy.
16. Social sciences study human societies from across the globe as well as the relationship of human beings with their social environment.
17. The main branches of social sciences are: Psychology, Sociology, Anthropology, Economics, Archaeology, History, Geography, Law and Politics
18. Social scientists help us to imagine alternative futures to, make sense of our finances. They contribute to our health and well-being. They might save your life. They can improve our children's lives and education. We need social science to guarantee our democracy.
19. Formal sciences use formal systems to produce knowledge. They explore the nature of different disciplines.
20. The most important branches of Formal sciences are Mathematics, Logic, Computer Science, Data Science, Statistics, Systems science, Artificial intelligence and Information technology
21. Formal sciences are important subjects because all of quantitative science depends on them. It is applied in Computer Science, Statistics, Mathematics.

22. Branches of science are often interconnected. For example, natural science and social science may overlap in fields such as environmental science. All the branches of science are part of a broader effort to understand the world we live in and our place within it.
23. Biochemistry, Bioinformatics, Cognitive science, Complex systems Physics, Artificial intelligence, Biomedical engineering, Chemistry and Ecology etc. are the few examples of interdisciplinary fields of science.
24. When two or more scientists work together to achieve a common goal, it is called scientific collaboration.

EXERCISE

Section I: Multiple Choice Questions

Select the correct answer:

1. Science means:

A) knowledge	B) observation	C) experiment	D) try and error
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2. Which one is the study the nature of our physical world and the universe?

A) natural science	B) social science	C) formal science	D) applied science
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3. Which one is the study of life and living organisms?

A) physical science	B) life science	C) earth science	D) soil science
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4. Which one includes all fields of natural science related to the planet Earth?

A) physical science	B) life science	C) earth science	D) soil science
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5. The study of how genes and how traits are passed down from one generation to the next is called

A) cell biology	B) genetics	C) ecology	D) microbiology
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6. Which field of study is interdisciplinary in nature?

A) cognitive science	B) anthropology	C) geography	D) glaciology
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7. Meteorology is the science of

A) weather	B) rainfall	C) earthquake	D) earth life
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8. Which of the following research is the example of collaborative research?

A) interdisciplinary research	B) public health
C) international space station	D) all of these
9. Which one is the study of organisms and how they interact with the environment around them?

A) cell biology	B) marine biology	C) genetics	D) ecology
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10. Why do we need social science? To guarantee our:

A) democracy	B) history	C) freedom	D) foreign policy
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Section II: Short Response Questions

1. Define the following branches of science and give at least one significance of the studying these branches:
 - a. Natural science
 - b. Social science
 - c. Physical science
2. Why do we divide science into branches?
3. Name the three main branches of science.
4. What are the three main branches of natural science?
5. Can you differentiate between the following?
 - a. Mechanics and electromagnetics
 - b. Organic chemistry and inorganic chemistry
 - c. Ecology and marine biology
 - d. Atmospheric science and climatology
6. Name any four careers involving:
 - a. Physical science
 - b. Life science
 - c. Earth Science
7. What examples can you give to understand the interdisciplinary fields of science?
8. Can you differentiate between individual research and collaborative research?
9. Why is collaboration important in research?

Section III: Extensive Response Questions

1. What are the applications of natural science?
2. Describe the main branches of social science.
3. Make a list of the main applications of social sciences.
4. Discuss the important branches of formal science.
5. What are the main applications of formal sciences?
6. What is the relationship between different branches of science?
7. Explain that science is a collaborative field.
8. How would you conduct a collaborative research study?